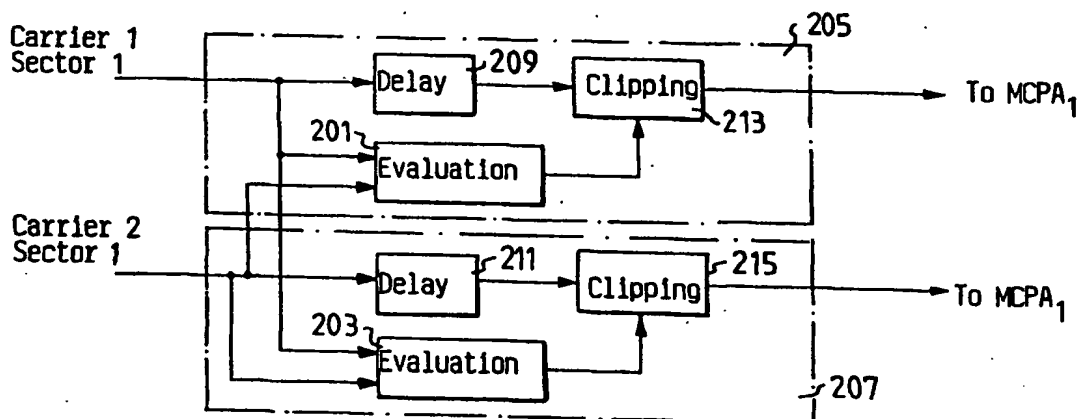




INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁷ : H04J 13/02, H04B 1/69	A1	(11) International Publication Number: WO 00/45538 (43) International Publication Date: 3 August 2000 (03.08.00)
(21) International Application Number: PCT/SE00/00146 (22) International Filing Date: 25 January 2000 (25.01.00) (30) Priority Data: 9900297-4 29 January 1999 (29.01.99) SE (71) Applicant: TELEFONAKTIEBOLAGET LM ERICSSON (publ) [SE/SE]; S-126 25 Stockholm (SE). (72) Inventors: LUNDH, Peter; Eksätravägen 218, S-127 61 Skärholmen (SE). SKOOG, Göran; Nordhemsgatan 66, S-413 09 Göteborg (SE). (74) Agents: SANDSTRÖM, Staffan et al.; Bergenstråhle & Lind- vall AB, Box 17704, S-118 93 Stockholm (SE).	(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>	

(54) Title: A METHOD AND AN APPARATUS FOR CLIPPING SIGNALS IN A CDMA SYSTEM



(57) Abstract

In a method and an apparatus for clipping CDMA carriers clipping for each CDMA carrier is performed on separate circuit boards and the clipping circuit has access to information regarding all carriers to be amplified by the same amplifier. Thus, since each carrier is clipped separately from all other carriers fed to the same amplifier, but having knowledge of the other carriers, a malfunction of the circuit board comprising the clipping circuit and/or clipping evaluation logic, will only affect that particular carrier and the other carriers can still be transmitted. Also, since clipping is carried out for each carrier separately, but taking into account information regarding the other carriers to be amplified by the same power amplifier, the clipping can take phase information into account when determining the clipping factor.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakhstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

A METHOD AND AN APPARATUS FOR CLIPPING SIGNALS IN A CDMA SYSTEM TECHNICAL FIELD

The present invention relates to a method and an apparatus for obtaining redundancy in a multi-carrier CDMA (Code Division Multiplex Access) system and in particular to a method and a system which is capable of reducing the ratio between the peak signal and the average signal in such a system, the so called Crest factor.

BACKGROUND OF THE INVENTION AND PRIOR ART

In radio transmission systems, power amplifiers are used in the base stations in order to obtain a sufficiently high output power. The power amplifiers used in conventional radio base stations meet requirements such as high frequency range and high linearity. However, the efficiency of conventional power amplifiers is poor.

Furthermore, it can be shown that if the ratio between the peak signal and the average signal is low, the efficiency of an output amplifier increases. The ratio between the peak signal and the average signal is commonly referred to as the Crest factor. It is therefore favourable that the Crest factor is kept as low as possible, while maintaining performance at a required level.

In CDMA (Code Division Multiplex Access) systems, several spreading channels, which overlap both in time and frequency, are added on top of each other, thereby forming a CDMA carrier. The CDMA carrier is then transmitted over an air interface to mobile telephones or other terminals.

In some CDMA systems, several CDMA carriers are amplified by a single power amplifier, a so called Multi Carrier Power Amplifier (MCPA). Furthermore, the spreading codes of the CDMA system behave in a random like manner and therefore the peak signal of a CDMA carrier becomes high. The peak signal is the signal formed by all sub-signal vectors pointing in the same direction and is therefore equal to the peak signal of each sub-signal multiplied by the number of sub-signals. The peak-to-

average signal ratio becomes even higher when several carriers are amplified by the same power amplifier (MCPA). This is not desired since the Crest factor then becomes higher.

In order to solve this problem, the amplitude of each carrier may be limited by clipping the signal before the channel shaping filter. The clipping procedure may be carried out in the analogue or the digital domain. Since the clipping is carried out before the channel shaping filter no spectral widening will occur, which otherwise would interfere with signal in neighbouring channels.

Another way of limiting the peak signal of the CDMA system is to clip the sum of the base-band signal vectors corresponding to each CDMA carrier. Thereupon the different carriers are separated, filtered in a channel shaping filter, modulated and amplified by a multi carrier power amplifier (MCPA).

Furthermore, the European patent application No. EP 0 849 905, discloses a CDMA multi code transmitter, wherein spread spectrum base band signals are summed and transmitted. The power consumption is reduced by delaying signals before the baseband signals are summed, so that the transmission timing of the different baseband signals are shifted with respect to each other.

However, none of the techniques above is capable of providing redundancy in the clipping procedure. Also, the techniques according to the above do not provide optimal performance, since the clipping is performed in the base band, and are not being able to take into account the different phases of different CDMA carriers, when these are to be amplified by the same power amplifier.

SUMMARY

It is an object of the present invention to increase the reliability of a CDMA system and at the same time reduce the Crest factor of the system.

This object is obtained by a method and an apparatus wherein clipping for each CDMA carrier is performed on separate circuit boards in a CDMA transmitter, and where the clipping circuit has access to information regarding all carriers to be amplified by the same amplifier.

Thus, since each carrier is clipped separately from all other carriers fed to the same amplifier, but having knowledge of the other carriers, a malfunction of the circuit board comprising the clipping circuit and/or clipping evaluation logic, will only affect that particular carrier and the other carriers can still be transmitted correctly.

Furthermore, clipping is carried out for each carrier separately and taking into account information regarding the other carriers to be amplified by the same power amplifier. The clipping procedure can therefore take phase information into account when determining the clipping factor. Therefore, an optimum Crest factor can be obtained for the composite CDMA signal transmitted via the common multi carrier power amplifier (MCPA).

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described in more detail by way of non-limiting examples and with reference to the accompanying drawings, in which:

- Fig. 1 is a schematic diagram illustrating a circuit board arranged to clip one CDMA carrier.
- Fig. 2 is a schematic diagram illustrating clipping in a CDMA system comprising two CDMA carriers for each power amplifier.

DESCRIPTION OF PREFERRED EMBODIMENTS

In Fig. 1, a schematic diagram illustrating a circuit board arranged to clip one CDMA carrier is shown. Thus, a number N , N being a positive integer ≥ 1 , of CDMA carriers 101 which are to be amplified by a common amplifier, a so called multi carrier power amplifier (MCPA) are connected to a circuit board 103.

The carrier to be clipped by the apparatus, here denoted carrier

1 is connected to a delay block 105 and to an evaluation logic block 107. The delay block 105 is connected to a clipping block 109, which is arranged to clip the carrier 1 in response to a control signal supplied by the evaluation logic block 107.

The other carriers, i.e. carriers 2 - N, are also connected to the evaluation logic block 107. Hence, all carriers to be amplified by the same MCPA are connected to the evaluation logic block 107, which therefore has access to all the carriers to be amplified by the same MCPA. The evaluation logic block calculates and estimate the amplitude of the composite base-band signal and sends clipping information to the clipping block 109. The clipping information can for example be a control signal indicating a factor in the range [0 - 1] which the carrier 1 should be multiplied with.

The carrier to be clipped is delayed in the delay block 105 in order to be phase matched with the clipping information, which can be delayed due to the processing time in the evaluation logic block 107.

The clipping block 109 is connected to a modulation block 111, wherein the clipped carrier 1 is modulated. The output terminal of the modulation block 111 is connected to a summation circuit 113 which in turn is connected to the MCPA (not shown).

In Fig 2, an example employing the principle according to the embodiment described in conjunction with Fig. 1 is shown. Thus, two carriers, carrier 1 and carrier 2, are to be transmitted in the same sector of a transmission system and to be amplified by the same power amplifier. The two carriers are connected to two different evaluation blocks 201 and 203 located on different circuit boards 205 and 207.

Carrier 1 is also connected to a delay block 209 located on the circuit board 205, and carrier 2 is connected to a delay block 211 located on the circuit board 207. The delay blocks 209 and 211 are connected to clipping circuits 213 and 215, respectively. The clipping circuits 213 and 215 are also

connected to the evaluation blocks 201 and 203, respectively, in order to receive information therefrom. The two evaluation blocks 201 and 203 hence both have access to all carriers, i.e. carrier 1 and carrier 2, to be amplified by the same amplifier. Based on this information the evaluation blocks calculates suitable factors which are transmitted to the clipping circuits 213 and 215, respectively.

Since all carriers are evaluated together on each circuit board, redundancy is obtained in the transmission system. Thus, evaluation is carried out on each board for all carriers, but only some of the carriers are clipped on the same circuit board. In the examples described herein one carrier is clipped on each circuit board, but two or more could of course be clipped if this would turn out to be advantageous. Thus, if one circuit board should malfunction only the CDMA carrier(s) clipped and processed on that particular circuit board would be affected. This is of course advantageous, since the robustness of the system increases.

Also, since clipping is performed separately for each carrier on different circuit boards, but the clipping evaluation is performed for the composite CDMA signal an optimum Crest factor is obtained for the composite CDMA signal transmitted via the multi carrier power amplifier (MCPA).

CLAIMS

1. An apparatus for limiting the amplitude of a code division multiple access (CDMA) signal comprising at least two CDMA carriers to be amplified by the same power amplifier,
characterized by
 - means for clipping each CDMA carrier separately, said clipping means being located on separate circuit boards,
 - means for clipping evaluation, the input terminals of said evaluation means being connected to each CDMA carrier and the output terminal(s) of said evaluation means being connected to each of the clipping means.
2. An apparatus according to claim 1, **characterized in** that the evaluation means is located at the same circuit board as one of the clipping means.
3. An apparatus according to claim 1, **characterized in** that a separate evaluation means is provided for each clipping means.
4. An apparatus according to claim 3, **characterized in** that the evaluation means are located at the same circuit board as the corresponding clipping means.
5. An apparatus according to any of claims 1 - 4, **characterized in** that at least two CDMA carriers are clipped on the same circuit board.
6. A method of limiting the amplitude of a code division multiple access (CDMA) signal comprising at least two CDMA carriers to be amplified by the same power amplifier,
characterized in that each CDMA carrier is clipped separately on separate circuit boards and that each CDMA carrier is clipped using information obtained from clipping evaluation having access to all CDMA carriers to be amplified by the same power amplifier.
7. A method according to claim 6, **characterized in** that the evaluation is carried out on the same circuit board as one of the clipping means.

8. A method according to claim 6, characterized in that the evaluation for the clipping of each carrier is performed in separate units.

9. A method according to claim 8, characterized in that the evaluation is carried out on the same circuit board as the corresponding clipping.

10. A method according to any of claims 6 - 9, characterized in that at least two CDMA carriers are clipped on the same circuit board.

11. A CDMA transmitter comprising the apparatus according to any of claims 1 - 5.

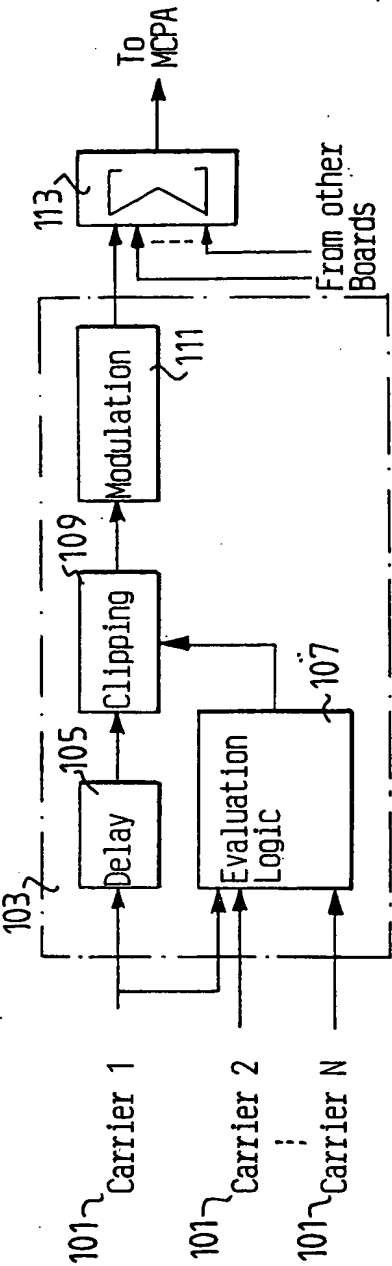


FIG. 1

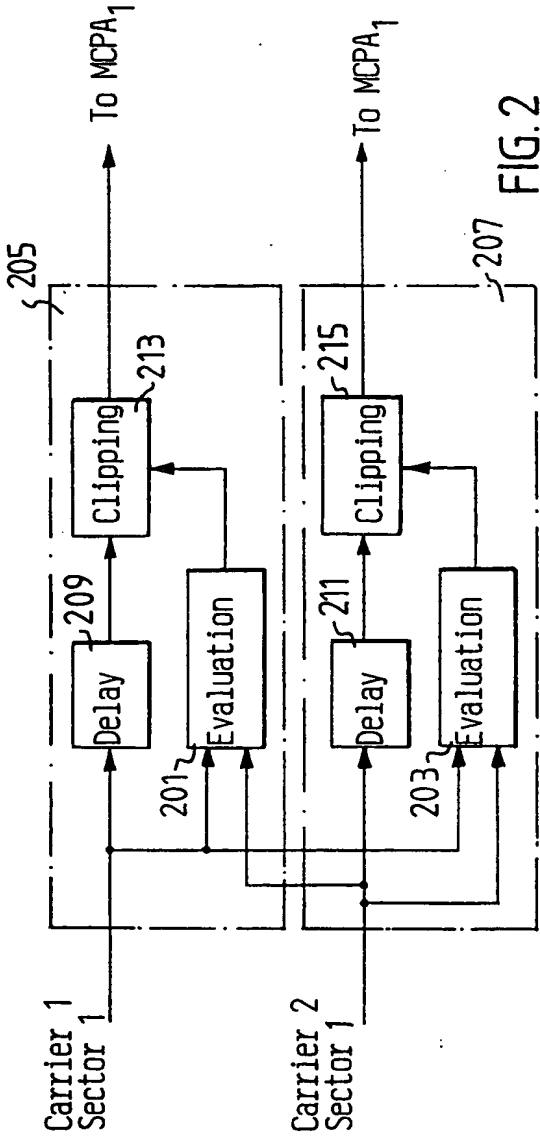


FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 00/00146

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04J 13/02, H04B 1/69

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9638944 A1 (DSC COMMUNICATIONS CORPORATION), 5 December 1996 (05.12.96), page 3, line 10 - page 5, line 1, claims 1,2 --	1,6
A	US 5621762 A (SCOTT L. MILLER ET AL), 15 April 1997 (15.04.97), see whole document --	1,6
A	GB 2313525 A (MOTOROLA LIMITED), 26 November 1997 (26.11.97), page 2, line 6 - page 3, line 25; page 8, line 20 - page 9, line 15 -- -----	1,6

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"I" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

9 May 2000

Date of mailing of the international search report

30-05-2000

Name and mailing address of the ISA/
Swedish Patent Office
Box 5055, S-102 42 STOCKHOLM
Facsimile No. +46 8 666 02 86

Authorized officer

Benny Andersson/cs
Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

02/12/99

international application No.

PCT/SE 00/00146

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9638944 A1	05/12/96	AU 705738 B	03/06/99
		AU 710839 B	30/09/99
		AU 2245799 A	20/05/99
		AU 2245899 A	27/05/99
		AU 5972896 A	18/12/96
		AU 5973296 A	18/12/96
		AU 5973396 A	18/12/96
		AU 5973796 A	18/12/96
		AU 5973896 A	24/12/96
		AU 5974896 A	18/12/96
		AU 5975096 A	18/12/96
		AU 5975896 A	18/12/96
		AU 5977896 A	18/12/96
		AU 5984896 A	18/12/96
		AU 5985396 A	18/12/96
		AU 6032896 A	18/12/96
		AU 6033896 A	18/12/96
		AU 6034896 A	18/12/96
		AU 6034996 A	18/12/96
		AU 6037696 A	18/12/96
		AU 6037796 A	18/12/96
		AU 6044296 A	18/12/96
		AU 6148996 A	18/12/96
		AU 6475896 A	18/12/96
		BR 9608335 A	05/01/99
		BR 9608346 A	05/01/99
		BR 9608347 A	05/01/99
		BR 9608656 A	18/05/99
		BR 9609300 A	15/06/99
		BR 9609468 A	02/03/99
		CA 2222705 A	05/12/96
		CA 2222734 A	05/12/96
		CN 1191045 A	19/08/98
		CN 1192831 A	09/09/98
		CN 1194071 A	23/09/98
		DE 69601795 D	00/00/00
		DE 69604584 D	00/00/00
		EP 0829150 A	18/03/98
		EP 0829174 A	18/03/98
		EP 0830748 A	25/03/98
		EP 0830749 A,B	25/03/98
		SE 0830749 T3	

INTERNATIONAL SEARCH REPORT

Information on patent family members

02/12/99

International application No.

PCT/SE 00/00146

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		EP 0830750 A,B	25/03/98
		SE 0830750 T3	
		EP 0830751 A	25/03/98
		EP 0830759 A	25/03/98
		EP 0830763 A	25/03/98
		EP 0830775 A	25/03/98
		EP 0834123 A	08/04/98
		EP 0872026 A	21/10/98
		EP 0872062 A	21/10/98
		ES 2129972 T	16/06/99
		GB 2301687 A	11/12/96
		GB 2301719 A	11/12/96
		GB 2301736 A	11/12/96
		GB 2301737 A	11/12/96
		GB 2301738 A,B	11/12/96
		GB 2301739 A	11/12/96
		GB 2301740 A,B	11/12/96
		GB 2301741 A	11/12/96
		GB 2301742 A	11/12/96
		GB 2301743 A	11/12/96
		GB 2301744 A	11/12/96
		GB 2301747 A	11/12/96
		GB 2301751 A	11/12/96
		GB 2301753 A	11/12/96
		GB 2301755 A	11/12/96
		GB 2301756 A	11/12/96
		GB 2302240 A	08/01/97
		GB 9510870 D	00/00/00
		GB 9511546 D	00/00/00
		GB 9513166 D	00/00/00
		GB 9513168 D	00/00/00
		GB 9513169 D	00/00/00
		GB 9513170 D	00/00/00
		GB 9513171 D	00/00/00
		GB 9513172 D	00/00/00
		GB 9513388 D	00/00/00
		GB 9513912 D	00/00/00
		GB 9514147 D	00/00/00
		GB 9603656 D	00/00/00
		GB 9603700 D	00/00/00
		GB 9603734 D	00/00/00
		GB 9603785 D	00/00/00
		GB 9606601 D	00/00/00
		GB 9609326 D	00/00/00
		GB 9609373 D	00/00/00
		JP 11506583 T	08/06/99
		JP 11506584 T	08/06/99
		JP 11506585 T	08/06/99
		JP 11506586 T	08/06/99
		JP 11506587 T	08/06/99
		JP 11509383 T	17/08/99
		US 5696766 A	09/12/97
		US 5742595 A	21/04/98
		US 5745496 A	28/04/98
		US 5809093 A	15/09/98

INTERNATIONAL SEARCH REPORT

Information on patent family members

02/12/99

International application No.

PCT/SE 00/00146

Patent document cited in search report			Publication date	Patent family member(s)	Publication date
WO	9638944	A1	05/12/96	US 5815798 A	29/09/98
				US 5838913 A	17/11/98
				US 5905963 A	18/05/99
				US 5909437 A	01/06/99
				US 5915216 A	22/06/99
				US 5918160 A	29/06/99
				US 5923668 A	13/07/99
				US 5930704 A	27/07/99
				WO 9638786 A	05/12/96
				WO 9638929 A	05/12/96
				WO 9638930 A	05/12/96
				WO 9638931 A	05/12/96
				WO 9638934 A	05/12/96
				WO 9638935 A	05/12/96
				WO 9638936 A	05/12/96
				WO 9638938 A	05/12/96
				WO 9638941 A	05/12/96
				WO 9638952 A	05/12/96
				WO 9638957 A	05/12/96
				WO 9638964 A	05/12/96
				WO 9638966 A	05/12/96
				WO 9638967 A	05/12/96
				WO 9638968 A	05/12/96
				WO 9638993 A	05/12/96
				WO 9638994 A	05/12/96
				WO 9638995 A	05/12/96
				WO 9639779 A	12/12/96
				ZA 9604142 A	03/12/96
				ZA 9604146 A	03/12/96
				ZA 9604147 A	27/08/96
				ZA 9604150 A	03/12/96
				ZA 9604151 A	03/09/96
				ZA 9604152 A	28/08/96
				ZA 9604153 A	03/09/96
US	5621762	A	15/04/97	AU 702758 B	04/03/99
				AU 5929496 A	09/01/97
				CA 2224572 A	27/12/96
				CN 1191647 A	26/08/98
				CZ 9704021 A	13/05/98
				DE 19681454 T	20/08/98
				EP 0883953 A	16/12/98
				GB 2317795 A,B	01/04/98
				GB 9726272 D	00/00/00
				JP 11507791 T	06/07/99
				NZ 309293 A	29/04/99
				SE 9704633 A	05/02/98
GB	2313525	A	26/11/97	WO 9642161 A	27/12/96
				EP 0840972 A	13/05/98
				GB 9610941 D	00/00/00
				JP 11510028 T	31/08/99
				WO 9745987 A	04/12/97